

Attachment A

Executive Summary

Engineering Evaluation/Cost Analysis

Slip 4 Early Action Area

Lower Duwamish Waterway Superfund Site, Seattle, WA

EXECUTIVE SUMMARY

The City of Seattle and King County are planning a sediment removal action for early cleanup of contaminated sediments in the Slip 4 Early Action Area (EAA) of the Lower Duwamish Waterway (LDW) Superfund Site in Seattle, Washington. Slip 4 is one of seven areas within the LDW that have been identified by the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) as candidate areas for early cleanup because sediments in these areas are associated with greater ecological and/or human health risk. The goal of this sediment cleanup is to significantly reduce unacceptable risks to the aquatic environment resulting from potential exposure to contaminated sediments in the slip. This cleanup will also reduce potential human health and ecological risks associated with polychlorinated biphenyls (PCBs) in sediment within the LDW.

This report presents the engineering evaluation/cost analysis (EE/CA) for the Slip 4 EAA removal action. It presents background information on the site, discusses available data and the proposed boundary of the removal action, documents the development and evaluation of alternatives for conducting the non-time-critical removal action (NTCRA), and discusses the rationale for the recommended removal action. Following public comment on this EE/CA, EPA, in consultation with Ecology, will select the removal alternative that will be implemented by the City and King County.

SITE CHARACTERIZATION AND RISK ASSESSMENT

Slip 4 is located on the east bank of the LDW, approximately 2.8 miles from the southern end of Harbor Island. The slip encompasses approximately 6.4 acres and is approximately 1,400 feet long, with an average width of 200 feet. Properties immediately adjacent to Slip 4 are currently owned by Crowley Marine Services, First South Properties, King County, and The Boeing Company. Crowley owns the majority of the submerged land within the Slip 4 EAA. A part of Crowley's submerged land (called the "inner berth") was historically dredged and permitted for navigation uses. The cleanup alternatives (summarized below) may affect Crowley's navigation uses on their land.

Numerous historical environmental investigations have included the collection of sediment data in Slip 4. Four sediment investigations were conducted in Slip 4 between 1990 and 1999. These investigations included an EPA site investigation (Weston 1999), a National Oceanic and Atmospheric Administration (NOAA) sediment characterization of the Duwamish River (NOAA 1998), a site assessment (Landau 1990), and a dredged material characterization (Exponent 1998). Results of these investigations are summarized in Section 2.3.1 of this report, and the resulting data were described in detail by SEA (2004).

Additional characterization data were collected in Slip 4 in 2004 (Integral 2004a). The initial investigation in April 2004 included collection of surface sediment samples at 29 locations, subsurface cores at 11 locations, and one intertidal composite sample. Bank samples were collected at six locations in July 2004. These investigations are summarized in Section 2.3 of this report and are described in detail by Integral (2004a).

Previous upland investigations adjacent to Slip 4 have included soil and groundwater sampling. These investigations were generally conducted as part of site assessments during property transfers, in conjunction with underground storage tank removal, or during construction when visible contamination (e.g., petroleum-staining) was observed or excavated soil required testing prior to disposal. A Resource Conservation and Recovery Act (RCRA) corrective action is being conducted at Boeing Plant 2. These investigations are also described in SEA (2004).

The removal action boundary encompasses approximately 3.6 acres in the northern half of Slip 4, as shown in Figure 2-18. The development and rationale for the proposed boundary for the Slip 4 removal action is described in the *Revised Draft Technical Memorandum on Proposed Boundary of the Removal Action*, contained in Appendix A of this report. This boundary memorandum was subject to public stakeholder review and comment. Development of the preliminary removal action boundary focused on the areal extent of PCBs because the historical data showed that PCBs were the primary contaminant of concern (SEA 2004); however, full-suite Washington State Sediment Management Standards (SMS) analyses were conducted, and all SMS analytes were considered. Areas where other chemicals exceeded the SMS Cleanup Screening Level (CSL) criteria were encompassed within the area exceeding PCB criteria; there are only two slight Sediment Quality Standard (SQS) exceedances outside the removal action boundary. All surface and subsurface sediment data were considered in developing the preliminary boundary. Additional bank soil and sediment data were collected in 2005 (Parametrix 2005; CH2M Hill 2005a; Bach 2005a, pers. comm.) and are summarized in this EE/CA. These data were used in this EE/CA to refine the boundaries of the removal action on the eastern bank of the slip.

The streamlined risk assessment, presented in Section 2.4, supports the need for the removal action. The ecological risk assessment for Slip 4 focused on the benthic invertebrate community by comparing chemical concentrations in surface sediments to the SMS. PCBs, bis(2-ethylhexyl) phthalate (BEHP), phenol and indeno[1,2,3-c,d]pyrene in surface sediments within the Slip 4 EAA exceed promulgated SMS standards for protection of benthic organisms. More mobile receptors (i.e., fish and wildlife) were assessed in the Phase 1 ecological risk assessment (ERA) for the LDW. The Phase 1 ERA indicted that PCB exposure concentrations were greater than concentrations associated with adverse effects for fish and great blue herons (based on egg data). Arsenic and copper were associated with adverse effects in fish. Other chemicals with exposure estimates greater than no-effects levels but less than the adverse-effects level for one or

more fish or wildlife species included PAHs, mercury, tributyltin (TBT), lead, and arsenic. The removal action is also supported by a summary of the LDW Phase 1 human health risk assessment that includes a list of potential risks to human health associated with PCBs in the LDW. In summary, contaminants found in Slip 4 sediments may have direct benthic community effects, and likely contribute to potential risks throughout the LDW to other ecological receptors and humans through diet exposure.

The proposed removal action will address ecological risks associated with contamination of sensitive ecosystems, which is indicated by the presence of PCBs above the SQS in surface sediments. These sediments provide important habitat for benthic invertebrates and juvenile salmonids, as well as other fish and shorebirds. The proposed removal action will also indirectly reduce human exposure to chemicals by removing or isolating sediment containing bioaccumulative chemicals (i.e., PCBs) that are found in seafood.

Areas in the LDW outside of the Slip 4 removal action boundary will continue to be evaluated by the LDWG, EPA, and Ecology under the LDW Remedial Investigation and Feasibility Study (RI/FS). The LDW RI/FS will include a baseline ecological and human health risk assessment to evaluate potential risks to human health and the environment posed by sediments in the LDW site, and will evaluate cleanup alternatives for areas of the site not addressed by the early actions.

GOAL, SCOPE, AND OBJECTIVES OF THE REMOVAL ACTION

The goal of the removal action at Slip 4 is to conduct an early cleanup that significantly reduces exposure of ecological and human receptors to sediment contamination, thereby reducing or eliminating adverse effects on biological resources in the removal area. The removal action objective is to:

- Reduce the concentrations of contaminants in post-cleanup surface sediments [biologically active zone (0–10 cm)] to below the state Sediment Quality Standards (SQS) for PCBs and other chemicals of interest.

The scope of the removal action includes approximately 3.6 acres within the removal boundaries identified in Section 3 of this EE/CA.

Potential sources of recontamination of Slip 4 sediments were also considered in defining the scope of this removal action. An evaluation of upland sources and source control efforts is included in Section 2.6 and Appendix B. Recontamination pathways of potential concern are bank erosion and stormwater flows that drain to outfalls in Slip 4. The cleanup alternatives described in the EE/CA include actions to address areas where eroding bank soils exceed the SQS.

Investigations by the City and King County indicate potentially significant ongoing sources of PCBs to Slip 4 from stormwater drainage. Control of stormwater sources is

outside the scope of this EE/CA. Ecology, King County, Seattle Public Utilities (SPU), and The Boeing Company are continuing to investigate and implement controls to address these sources. It is important that these sources are adequately controlled prior to construction of the Slip 4 removal action to minimize the potential for recontamination of Slip 4 sediments. Ecology will make the final decision regarding source control effectiveness and completeness (Ecology 2004). Following EPA and Ecology's assessment and before implementing cleanup actions, the City of Seattle and King County will consider whether or not source control is considered adequate to prevent recontamination to levels of concern.

IDENTIFICATION OF REMOVAL ACTION ALTERNATIVES

Section 4 includes an initial screening of technologies that may be applicable to cleanup of Slip 4. In Section 5, the retained technologies are developed into four removal alternatives that range from an emphasis on containment (with minimal removal) to an emphasis on removal (with minimal containment). The four alternatives developed for the Slip 4 removal area are:

- **Alternative 1** is based on a containment approach, primarily involving capping of contaminated sediments in place. Prior to capping, limited excavation and offsite disposal would occur at the head of the slip to accommodate outfall grading requirements, and on banks to ensure no net loss of aquatic habitat. Derelict piling and debris would be removed. Engineered sediment caps would be constructed over the entire Slip 4 removal area, including engineered slope caps on the affected banks. Portions of the cap would be thickened and graded to expand and enhance shallow subtidal and intertidal habitat. Alternative 1 limits the landowner's potential use of a permitted berthing area in the inner portion of the slip. As compensation, the City of Seattle is willing to purchase the affected property from the landowner if this alternative is selected.
- **Alternative 2** includes targeted removal of contaminated sediments at the head of the slip, along with capping. The objectives of dredging would be to remove near-surface material with the highest concentrations of contaminants, minimize changes to mudflat habitat at the head of the slip, and accommodate outfall flows. Piling and debris would be removed, and banks would be excavated to ensure no net loss of aquatic habitat. Engineered sediment caps would be constructed over the entire Slip 4 removal area, including engineered slope caps on the affected banks. Portions of the cap would be thickened and graded to expand and enhance shallow subtidal and intertidal habitat. Alternative 2 limits the landowner's potential use of a permitted berthing area in the inner portion of the slip. As compensation, the City of Seattle is willing to purchase the affected property from the landowner if this alternative is selected.

- **Alternative 3** includes dredging in the head and inner berth areas of the slip, along with capping. The objectives of dredging would be to remove near-surface material with the highest concentrations of contaminants, minimize changes to mudflat habitat at the head of the slip, accommodate outfall flows, remove contaminated material in the inner berth to re-establish historically permitted navigation depths (-15 feet MLLW), and attain a clean dredged surface in the inner berth. The dredging would be limited in scope to minimize impacts to adjacent structures and outfalls. Derelict piling and debris would be removed, and banks would be excavated to ensure no net loss of aquatic habitat. Engineered sediment caps would be constructed in the areas outside the inner berth, including engineered slope caps on the affected banks.
- **Alternative 4** includes the greatest amount of dredging within Slip 4 among the four alternatives. The dredging would have the overall objective of removing all contaminated material where reasonably feasible, but the dredging would be limited in scope to minimize impacts to adjacent structures and outfalls. As with Alternative 3, this alternative would re-establish historically permitted navigation depths in the inner berth. Piling and debris would be removed, and banks would be excavated to ensure no net loss of aquatic habitat. To minimize habitat disturbances by the deepening, the areas outside the inner berth would be backfilled with clean material. In areas where dredging could not remove all contaminated materials, the backfill would be designed to function as a cap. Engineered slope caps would also be constructed in bank areas.

In developing the removal alternatives, consideration was also given to a “maximum feasible removal” alternative, involving removal of most or all of the contaminated sediments within Slip 4, with an objective of avoiding the need for capping. Site limitations (including slope stability, structural stability of piers, outfalls, and bulkheads, and depth of contamination) would require extensive engineering measures to accomplish complete removal of all contaminated material. This approach would offer potentially greater long-term effectiveness because most of the contaminated materials would be removed from the site. However, it would have greater short-term impacts during construction, could require two construction seasons to implement, and would have substantially greater incremental costs than other, equally protective alternatives. The incremental cost of this approach is considered to be substantial and disproportionate to any benefits, and therefore the “maximum feasible removal” approach was not carried forward.

A no-action alternative was not considered for the Slip 4 removal area because it would not satisfy the removal action objectives or meet the needs and purposes of a NTCRA.

ANALYSIS AND RECOMMENDATIONS

The four removal alternatives are analyzed in Sections 5 and 6 with regard to EPA's criteria of effectiveness, implementability, and cost. This analysis is summarized below:

- **Effectiveness:** The effectiveness evaluation considers overall protection of human health and the environment, achievement of the removal action objective, compliance with applicable or relevant and appropriate requirements (ARARs), reduction of toxicity, mobility, or volume through treatment, short-term effectiveness, and long-term effectiveness and permanence. For overall effectiveness, Alternative 2 ranks highest, followed by Alternatives 1, 4, and 3. Each alternative would provide overall protection of human health and the environment and can achieve the removal action objectives. Each alternative can be implemented in compliance with ARARs. Alternative 2 provides the greatest quantity and highest quality habitat for threatened Puget Sound chinook and Coastal/Puget Sound bull trout, with Alternative 1 providing slightly less habitat benefits. Alternatives 3 and 4 would significantly decrease shallow subtidal and lower intertidal habitat area and would require more armoring, which may decrease habitat quality. Alternatives 1 and 2 are similar in their short-term effectiveness and are not expected to pose significant recontamination risk outside the removal area. Due to the greater amount of dredging and longer project duration, Alternatives 3 and 4 would pose a greater short-term risk of recontamination caused by dredging and would have greater short-term water quality impacts during dredging. Each alternative would be effective in the long-term; however the consequences of possible cap erosion would be greatest under Alternative 1. The potential for erosion is greatest under Alternatives 3 and 4 (due to navigation), and hence Alternatives 3 and 4 may require somewhat greater maintenance over the long-term. Each alternative would include institutional controls, long-term monitoring, and periodic reviews to ensure long-term protectiveness.
- **Implementability:** The implementability evaluation considers the technical and administrative feasibility of implementation, as well as the availability of materials, equipment, and services. For overall implementability, Alternatives 1 and 2 rank highest, followed by Alternatives 3 and 4. Each of the alternatives can reliably be implemented; however, Alternatives 3 and 4 would require additional consideration of design, monitoring, and construction elements so that a clean sediment surface is left in the inner berth and in adjoining areas south of the removal boundary. Under Alternatives 3 and 4, removal of under-pier sediments and placement of under-pier cap material would also require special provisions.
- **Cost:** The cost evaluation considers capital costs, long-term monitoring and maintenance costs, and total present worth costs. Alternative 1 is the least expensive alternative, followed by Alternatives 2, 3, and 4. Alternative 2 would

cost approximately 15 percent more than Alternative 1. Alternative 3 would cost roughly 50 percent more than Alternative 1. Alternative 4 would cost roughly twice as much as Alternative 1.

The City and King County recommend Alternative 2 because it represents the most practical and cost-effective balance of contaminant removal and containment while maximizing long-term effectiveness, providing the greatest habitat benefits, and minimizing potential long-term maintenance requirements.

Attachment C

ARARs, Table 6-1

Engineering Evaluation/Cost Analysis

Slip 4 Early Action Area

Lower Duwamish Waterway Superfund Site, Seattle, WA

Table 6-1. Applicable or Relevant and Appropriate Requirements.

Source	Requirement
Washington State Model Toxics Control Act (WAC 173-340-440)	These regulations are applicable to establishing institutional controls for capping. Each alternative would comply with these requirements by implementing appropriate institutional controls in capped areas.
Federal Water Pollution Control Act/ Clean Water Act (CWA) (33 USC 1251-1376; 33 CFR 320-330; 40 CFR 230-231)	These regulations establish the basic structure for regulating discharges of pollutants into the waters of the United States. Section 404 regulates the discharge of dredged material or fill into navigable waters. Section 401 requires water quality certification for such activities. The implementing regulations of these laws are applicable to sediment dredging and capping actions. Each alternative would comply with these regulations through design elements to avoid or minimize adverse effects, the implementation of best management practices, and a water quality monitoring program.
Washington State Water Quality Standards for Surface Waters (WAC 173-201A)	Standards for the protection of surface water quality have been established in Washington State. Acute marine criteria are anticipated to be relevant and appropriate requirements for discharge to marine surface water during sediment dredging and capping. Each alternative would comply with these regulations through the implementation of best management practices and a water quality monitoring program.
Washington State Sediment Management Standards (WAC 173-204)	Chemical concentration and biological effects standards are established for Puget Sound sediments and are applicable to each alternative. For each alternative, chemical concentrations in surface sediment within the removal boundary will be below the SQS following construction.
Construction in State Waters, Hydraulic Code Rules (RCW 77.55; WAC 220-110)	Hydraulic code rules for construction projects in state waters have been established for the protection of fish and shellfish, and are applicable to Slip 4 construction activities. Each alternative would comply with the substantive requirements of these regulations by implementing best management practices for the protection of fish and shellfish, as recommended by the Washington Department of Fish and Wildlife.
Federal Endangered Species Act of 1973 (16 USC 1531 et seq.; 50 CFR 216-226; 50 CFR 402)	These regulations are applicable to any actions performed at this site as this area is potential habitat for threatened and/or endangered species. A biological assessment will be conducted in conjunction with the removal design documents in consultation with NOAA Fisheries and USFWS. Each alternative is expected to comply with the substantive requirements of the Act through design elements to avoid or minimize adverse effects, and implementing best management practices and conservation measures as recommended by NOAA Fisheries and USFWS.
Resource Conservation and Recovery Act [40 CFR 260 - 268]	Dredged/excavated material may be subject to RCRA regulations if it contained a listed waste, or if it displays a hazardous waste characteristic, for example by the Toxicity Characteristic Leaching Procedure (TCLP). RCRA regulations may potentially be ARARs for the storage, treatment, and disposal of the dredged/excavated material unless an exemption applies. Based on site-specific information, it is likely that none of the sediments or soils meet the RCRA definition of hazardous waste.

Table 6-1 (continued). Applicable or Relevant and Appropriate Requirements.

Source	Requirement
Toxic Substances Control Act (TSCA) (40 CFR 761)	<p>This regulation is applicable to excavated or dredged materials containing PCBs. Each alternative would comply with TSCA by disposing all soils and sediments with total PCB concentrations greater than 50 mg/kg at a TSCA landfill.</p> <p>Disposal of soils and sediments with total PCB concentrations less than 50 mg/kg will follow the substantive requirements of 40 CFR 761.61, cleanup and disposal requirements for PCB remediation waste. Material meeting the definition of PCB remediation waste (761.3) would be disposed of using the three options under 761.61 (self-implementing option; performance-based option, and a risk-based option). The risk-based option under 761.61(c) would be expected to be selected at this site, and it may incorporate the requirements of the self-implementing option. If so, then PCB remediation wastes containing less than 50 mg/kg are allowed to be disposed of at non-TSCA municipal or solid waste landfills.</p>
Essential Fish Habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation and Management Act (50 CFR 600)	<p>This act identifies and protects important habitats of federally managed marine and anadromous fish species. This act is relevant and appropriate to cleanup actions at Slip 4. EPA makes a determination about whether a proposed action may adversely affect EFH.</p>
US Fish and Wildlife Coordination Act. (16 USC 661-667e)	<p>This statute establishes criteria to protect fish and wildlife that could be affected by proposed or authorized federal projects involving "impounding, diverting, or controlling waters." This act is relevant and appropriate to cleanup actions at Slip 4. EPA will consult with the U.S. Fish and Wildlife Service and the Washington Department of Fish and Wildlife regarding the potential effects of the project on fish and wildlife and identify measures that would mitigate those impacts. Also, the statute requires that adequate provision be made for the conservation, maintenance, and management of fish and wildlife resources and their habitats.</p> <p>The ESA consultation described above will also satisfy the substantive requirements of the Fish and Wildlife Coordination Act.</p>
Migratory Bird Treaty Act (16 USC 703-712)	<p>Governs the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts and nests. This act is applicable to cleanup actions at Slip 4. Actions will be taken as needed to protect habitat for migratory birds, and avoid disturbances of their nests and eggs.</p>
Rivers and Harbors Appropriations Act (33 USC 403; 33 CFR 320 - 323)	<p>Section 10 of this act establishes permit requirements for activities that may obstruct or alter a navigable waterway. Activities that could impede navigation and commerce are prohibited. These substantive permit requirements are anticipated to be applicable to dredging and capping actions that may affect the navigable portions of the waterway. EPA will evaluate compliance with these regulations concurrently with their CWA 404 evaluation.</p>

Table 6-1 (continued). Applicable or Relevant and Appropriate Requirements.

Source	Requirement
<p>Washington Solid Waste Management Act (RCW 70.95)</p> <p>Solid Waste Handling Standards (WAC 173-350)</p>	<p>These regulations are applicable to the disposal of non-hazardous waste generated during remedial activities. These standards set minimum functional performance standards for the proper handling and disposal of solid waste, identifies functions necessary to assure effective solid waste handling programs at both the state and local level, and follows priorities for the management of solid waste.</p> <p>Because the disposal of the dredged sediments and debris will take place in a permitted solid waste landfill that is outside the site boundaries, both substantive and administrative requirements of applicable regulations must be met for this activity.</p> <p>The offsite rule (40 CFR 302.440) of the NCP requires that solid and hazardous waste offsite landfills to which CERCLA hazardous substances are being sent must be acceptable to EPA. The project specifications will require the contractor to obtain EPA approval of the proposed disposal facility.</p> <p>In practical terms, the requirements for disposal of dredged sediments will be found in the permit of the landfill that agrees to accept the waste. For example, the Roosevelt Regional Landfill's permit allows it to accept sediments that, while dewatered, do not need to pass the paint filter test (to limit free-draining liquids) before disposal.</p>
<p>Washington Dangerous Waste Regulations (WAC 173-303)</p>	<p>These state rules regulate the generation, handling, storage, and disposal of dangerous waste. Dredged material and debris would be evaluated for dangerous waste designation in accordance with these regulations.</p> <p>Because the disposal of the dredged sediments and debris will take place in a permitted solid waste landfill that is outside the site boundaries, both substantive and administrative requirements of applicable regulations must be met for this activity.</p>
<p>Executive Order for Floodplain Management (Executive Order 11988; 40 CFR Part 6, App. A)</p> <p>FEMA National Flood Insurance Program Regulations (44CFR 60.3 (d)(3))</p>	<p>Executive Order 11988 requires measures to reduce the risks of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains. The NFIP regulations prohibit encroachments, including fill, within the adopted regulatory floodway unless engineering analyses demonstrate that the proposed encroachment would not increase flood levels. Each alternative meets the requirements of the Executive Order. EPA's sediment guidance document (USEPA 2005b) states that although not ARARs, the Agency normally follows executive orders as a matter of policy. The dredge and fill activities in Slip 4 are outside the floodway limits, and therefore the net filling under Alternatives 1 and 2 is allowable under the NFIP regulations.</p>
<p>Native American Graves Protection and Repatriation Act (NAGPRA) (25 USC 3001 et seq.; 43 CFR 10)</p>	<p>NAGPRA and implementing regulations are intended to protect Native American graves from desecration. These regulations are potentially applicable. Excavation or dredging must cease if Native American burials or cultural items are discovered.</p>
<p>American Indian Religious Freedom Act (42 USC 1996 et seq.)</p>	<p>These regulations are potentially applicable. Excavation or dredging must cease if Native American sacred religious sites, burials, or cultural items are discovered.</p>

Table 6-1 (continued). Applicable or Relevant and Appropriate Requirements.

Source	Requirement
National Historic Preservation Act (16 USC 470f; 36 CFR 800)	These regulations are potentially applicable. If Native American or other cultural materials are discovered as part of the dredging or excavation, alternatives must be evaluated to avoid, minimize, or mitigate the impact.
Archaeological Resources Protection Act (16 USC 470 et seq.; 43 CFR 7)	These regulations are potentially applicable. Excavation or dredging must cease if archaeological resources are discovered.
Washington State Shoreline Management Act (RCW 90.58) Shoreline Management KCC Title 25	KCC Title 25 regulations implement the State Shoreline Management Act, and are applicable to all building, excavation, dredging, and filling within 200 feet of regulated shorelines. May require removal of illegal fill placed after 1972. Changes to the shoreline resulting from cleanup will be evaluated in design.
Critical Areas KCC Title 21A.24	State Law (the Growth Management Act) requires local governments to develop regulations to protect critical areas, but the content of these regulations is left to local government discretion – these ordinances are not subject to State approval. These will be addressed as To Be Considered for the Slip 4 CERCLA cleanup.